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THE INTERACTIONS OF PLANTS AND ANIMALS ON RABBIT ISLAND, WILSON'S PROMONTORY, VICTORIA

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Abstract

Rabbit Island was visited during May 1965 in preparation for a study on the interactions of rabbits and island vegetation and the effects upon the breeding of *P. tenuirostris* and *E. minor*. Details of the island and its vegetation are given and the possible stages leading to the dominance of *Poa poiformis* are discussed.

Introduction

Rabbit Island was visited from 9 to 13 May and again on 27 October 1965. The island, some 80 ac. in area, lies less than a mile from the north-eastern side of Wilson's Promontory.

This report forms part of a survey presently being undertaken on the interrelations existing between introduced mammals (such as rabbits, sheep, rats and foxes) and island nesting seabirds such as *Puffinus tenuirostris*, the Tasmanian Muttonbird, and *Eudyptula minor*, the Fairy Penguin. It will be the basis for more detailed studies to be pursued there. Reports on the Promontory islands, including Rabbit Island, have been made by Gillham (1961, 1962) who has also discussed the effects of mammals and burrowing seabirds on island vegetation (1955, 1956), but no other reports concerned with the area have been found.

Physical Structure

The island rises to 194 ft and is a grey granite similar to that found on the adjacent parts of the Promontory. Outcrops of the granite, varying in size, occur over the island though they are not present on the W. side, where a sand-filled 'valley' exists, extending from a small beach up to the centre of the island where it meets with a sand blow across the summit (see Pl. 35).

Erosion gullies, due to the rapid run-off of rain, are found near the summit and along the eastern side. There is a small seepage channel, which is said to form a stream after rain, at the southern end of the beach.

On the E. and S. sides are cliffs, undercut in places by sea caves, but elsewhere the rise from the sea-level to the summit is more gradual.

Protection from the NW.-SW. winds is provided by the Promontory mountains in the vicinity, which reach 2,092 ft (Mt Vereker in the SW.) and 1,050 ft (Mt. Roundback in the NW.). It is this shelter which, together with the local currents, has presumably been responsible for the sand beach becoming established on the NW. side.

Vegetation

A list of the plants found is given in the Appendix and comparison is made with the list given by Gillham (1961).

The dominant (commonest) species over the whole island, as on many Bass Strait islands, is *Poa poiformis*. In the extensive rookery areas the *Poa* is inter-

spersed with bare earth patches. The almost pure stand, over most of the island two to three feet high, becomes lower and increasingly interspersed with sand around the eroded area. However, *Senecio lautus* forms a belt along the northern and southern limits of the sand blow and is found in the valley.

Though the *Poa* is overall dominant, small communities of *Pteridium esculentum*, *Urtica urens* and *Carduus tenuifloris* become locally dominant or co-dominant with the *Poa* within the sand valley; *Juncus pallidus* is also occasionally dominant.

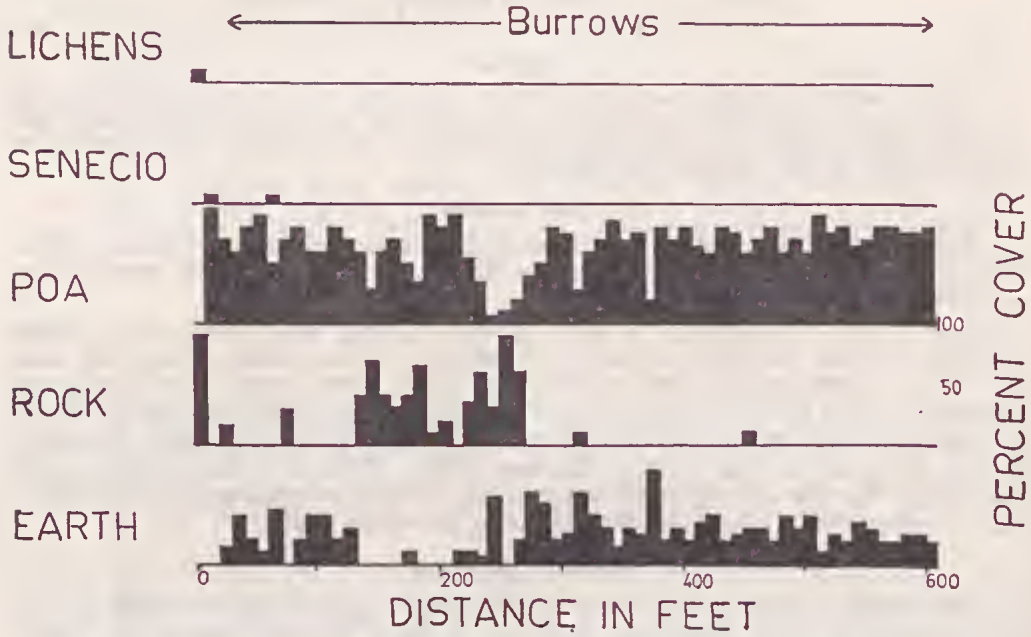

FIG. 1—Line transect a. From splash zone on west side towards north end (100°). 610 feet long, intervals of 10 feet.

Transects (Fig. 1 & 2) show the overall dominance of *Poa* and the restricted number of species is clearly indicated by transect (a), which was made from the splash zone of the NW. coast, easterly through the rookeries as indicated. Bare soil, a result of penguin and muttonbird activity, occurs frequently across the northern end of the island and the same is true for the southern portion though a transect was not made. In transect (b), *Poa* is dominant again, but it can be seen that occasional communities other than *Poa* do occur. This transect, made from the beach to the summit, also indicates the reduction of vegetation within the sand-blow region, though no rookeries were crossed.

Remains of stumps of *Acacia longifolia*, some charred, indicate that it was at one time extensive over the N. and W. regions of the island. Fires presumably contributed to the reduction. Only a few shrubs, reaching six feet in height, now exist on the summit and at a site on the western side. Those on the summit, behind a sand hummock, lean towards the E. and appear to be mostly dead or dying. Another large shrub, *Leptospermum laevigatum*, was present at two sites (dark patches in Pl. 35) and the smaller *Correa alba* was also found along the W., sheltered side.

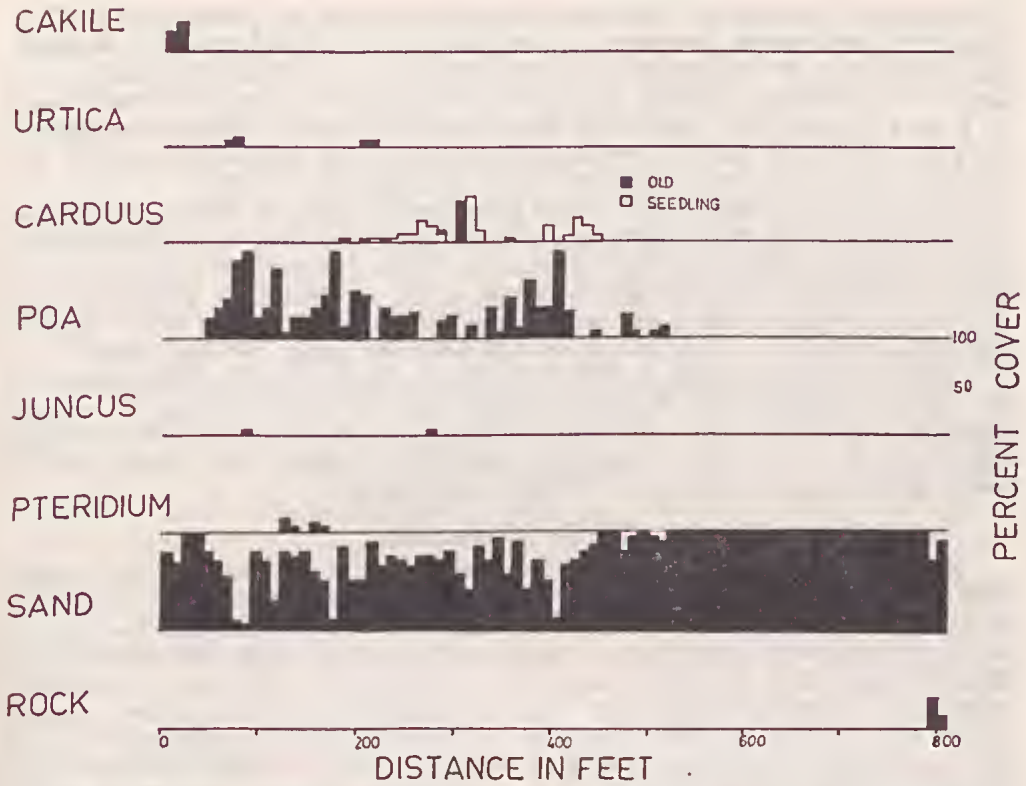

FIG. 2—Line transect b. From HW mark on sand beach to summit (110°). 810 feet long, intervals of 10 feet.

Seedling *Senecio* had become thinly established across the sand blow by the second visit and occasional *Poa* and *Cerastium* had also appeared.

The sand beach is backed by an embryo dune system of pure *Cakile maritima.* Along the rocks, in the supralittoral zone, *Disphyma australe* and *Carpobrotus rossii* are found; these, together with *Stellaria media*, extend high up the cliffs in places. The ferns *Microsorium diversifolium* and *Asplenium obtusatum* are found in rock crevices along the coast.

Factors Influencing the Vegetation

The vegetation, an almost pure stand of *Poa* throughout the island, can be considered as being influenced by climatic and edaphic factors and by biotic factors (e.g. rabbits, birds and man). Gillham (1961) states that 'very few subordinates have survived the combination of summer drought, burrowing birds and grazing rabbits on the main part of the island'; the influence of wind should also be considered.

(i) Abiotic Factors

Rainfall, in coastal Victoria, is relatively uniform throughout the year as a result of the prevailing westerlies, although Rabbit Island may lie within a possible rain shadow created by mountains to the W.

Records of wind at the Promontory lighthouse during the period June 1962 to May 1965 show the predominance of westerlies; indeed 50·9 per cent of all winds came from SSW.-W. Bird (1965) considered that 'the minimum wind speed necessary for sand drifting is slightly less than Beaufort scale 4 (about 10 knots)', and so I have analysed the records for winds above 10 knots. Westerlies made up 39·2 per cent of the total in this category. It is of interest that slightly over 50 per cent of the winds recorded during the period were above 10 knots.

Accumulation of humus and charred plant-remains, together with the weathered granite sand, has led to the formation of a dark soil found over most of the island. However, in the valley, the light coloured sand is unchanged and the grain size is large, particularly over the eroded area where a grit, predominantly quartz, remains. Soil samples, taken from inside and outside rookeries, showed a wide range of pH values, from 4 to 7 (by laboratory determination using Universal Indicator at 1 : 5 dilution). The extremes were both outside rookeries, near the summit and on the east side respectively. Rookery samples were all acidic, having an average value of 4·6. Water retention was low, the average percentage present by weight being only 4·45, and loss of nutrients provided by guano must be high as the result of constant leaching, there being no clay layer.

(ii) Biotic Factors

Rabbits. The introduction of rabbits on to islands, in this case in 1836 (Stokes 1846), used to be standard practice, the rabbits supplementing supplies of mutton-birds or fish as a source of fresh food for mariners. The rabbit, which has 'greater ability to utilize very small plants (compared with stock)' (Ratcliffe 1959), is the limiting factor both to growth and to the number of species, since it will feed selectively, conferring upon some plants a 'competitive advantage over others' (Myer & Poole 1963). Added to this is the destruction and denudation of the soil surface. Taylor (1955) has shown that, on Macquarie Island, soil slip and erosion occur on slopes of more than 25°; such an action could have taken place on the eastern side of Rabbit Island as evidenced by the slope of pure sand which inclines at about 45°.

The intense grazing by rabbits would reach maximum importance and have the most noticeable effects during a summer drought where there is no standing water and the run-off stream is said to be below the surface. Hayward's experiments (1961) on the rabbit's ability to withstand long periods of water deprivation, showed that the majority of mortalities occurred about two months after the initiation of the drought period. 'Quite probably starvation, as well as dehydration' were the causes of mortality, according to Hayward; the starvation being caused by 'a decreased food intake brought about by a severely restricted water intake'. On Rabbit Island, reduced availability of water (which may not have been totally absent), together with a decrease in plant growth would limit the number of rabbits which the island could support and the growth and spread of plants would be restricted by the increased rabbit grazing-pressure.

During my visits no rabbits were seen, though Gillham (1961) considered that the 'estimated population (in 1959) there is small in relation to the total area, but large in relation to the amount of available food'. Local fishermen told me that rabbits were present in January 1965, indicating that myxomatosis became established on the island about February 1965, presumably as a result of infection from a source on the mainland. Initial infection would probably have been by a wind-blown mosquito; there being no evidence of intermittent pools present to allow breeding, further spread on the island would probably have been by fleas or sand

flies, both known to be vectors. Myxomatosis, no doubt coupled with the summer drought and the annual food shortage, appears to have been almost completely destructive in this case. Some 150 corpses, estimated to be about two months old, were found, but only one fresh set of droppings and tracks. New growth of all plants examined was found to be completely untouched.

Gillham (1961) worked out the species: acreage ratio from a series of islands around the Promontory and found a close correlation between this ratio and degree of exposure. Rabbit Island (80 ac. with 31 recorded species) and Cliffy Island (100 ac. and 39 species) had an approximately equal species : acre ratio. Cliffy, some ten miles to the east of Rabbit, was more exposed and she concluded that the effect of spray-bearing winds was to depress the species total, whereas on Rabbit Island 'the number of species was severely depressed by rabbit grazing'.

Birds. Gillham (1955) has discussed the influence of trampling, by colonial nesting sea-birds and mammals, on the vegetation of islands. In general, she concludes that 'like grazing and wind action, it restricts the number of species and favours the low-growing or hemicryptophytic habit in plants'. Mutton-birds and penguins have either regular paths for take-off into the wind or tracks for walking up and down a slope. These paths are devoid of vegetation. In the process the binding, originally sub-surface parts of the plants, such as *Poa*, become broken up and destroyed. Given certain conditions this could well lead to erosion, the birds aiding the process by moving the soil downhill.

Mutton-birds and penguins occur in mixed colonies over most of the island. The trampling action of the former is rather limited since the steep slopes make take-off relatively easy. However, burrowing of both species must be an important factor, and in addition the penguins have formed a large path system which starts on the southern end of the beach and radiates out into subsidiary tracks which lead over the island. Such tracks aid the formation of erosion gullies.

Man. The influence of man on the vegetation has been, and is still, of considerable importance both by the introduction of rabbits and the initiation of fires. Extensive firing of the vegetation, to facilitate the harvesting of mutton-birds, probably removed the original scrub flora, enabling the *Poa* to become dominant. Haydon (1846) mentions that there were rabbits on the island, and that on the 'west side of the island, there are the remains of a hut and garden'. Presumably fire was used to clear the garden area; the island was swept by fire in 1941 and again in 1955 though less severely (A. G. Galbraith, *in litt.*).

Discussion

The present vegetation of many Bass Strait islands, mostly tussock-grass, suggests that man has been responsible for the removal of scrub species; early records indicate that few islands were without occupants (Plomley 1966). Rodondo Island, about 10 miles to the south of the Promontory, is thought to be an exception. Here there is an extensive scrub flora, including *Melaleuca pubescens, Eucalyptus bicostata, Myoporum insulare* and *Correa alba* (Bechervaise 1947). He considers that the island has never known human interference. 'It contains several hundred acres which, in that they have never been burnt, are of a quality rare in the Australian bush. The only signs of fire were on two comparatively recent lightning-struck trees from which it was obvious no flames had spread.'

Poa poiformis is present and in many areas grows beneath the trees. Thus the vegetation of Rabbit Island could have been one dominated with shrub species in the interior and having a coastal belt of *Poa*. The burning off and introduction of rabbits, which would prevent any regeneration of shrubs, could have led to the

present structure. Wind, with salt spray, must also have been important in preventing a return to the climax. (An interesting comparative situation exists on Great Glennie Island, six miles W. of the Promontory, where the vegetation on the N. end is largely *Poa* dominated, with few shrubs, whilst the S. has a *Casuarina* forest with a variety of smaller tree species, e.g. Acacia. *Poa* is present where the *Casuarina* is sparse and also in open areas which, however, are not always the most exposed to prevailing winds. In this instance, perhaps spray-bearing wind has been a factor in suppressing re-colonization by shrubs after burning on the north end, although there is no obvious evidence of fire now; rabbits are not known to have been present.)

Burrowing, by bird or rabbit, must assist in causing erosion. On Rabbit Island there are few burrows in the sand valley due to the birds' inability to maintain them in regions where there is little or no binding agent or soil consolidation. The process of burrowing also exposes the normally subterranean parts of the plant, covers up those parts above the surface to some extent and materially alters the conditions below soil level, by aerating, introduction of water and manuring (Gillham 1956). Caving in of burrows, whether by trampling or as the result of normal breakage, is of considerable importance in assisting further erosion in the area. There was no sign of rabbit warrens and I assume that the rabbits utilized bird burrows, or that their own burrows were indistinguishable in the rookeries.

The erosion across the summit has resulted in the removal of smaller sand particles and thus only large-grained sand is left. Sheet erosion has taken place and erosion gullies, caused by rain, are furthering the process. These gullies have become quite extensive and deep, particularly on the eastern side. In many places there are centres of erosion around what used to be mutton-bird burrows. In fact the whole of the now eroded area was at one stage occupied by birds, as is shown by the large number of burrows and bird remains which are present in the sand. The erosion gullies have contributed largely to the formation of outwashes, or spills, on the eastern side.

From consideration of the vegetation of Rabbit Island and the factors known to have influenced it, one can construct a possible sequence of interactions resulting in the present situation.

If the vegetation of the rookery can be considered as being relatively stable, in that there is an equilibrium between erosion and subsequent regeneration, then the following scheme could explain the formation of the Rabbit Island vegetation:

1. Vegetation stable within rookery.
2. Some small-scale erosion due to trampling and burrowing, wind and drought exert little influence.
3. Introduction of rabbits.
4. Reduction of vegetation and increase in dominance of some species due to selective feeding.
5. Erosion influence of wind and drought becoming more important.
6. Fires, caused deliberately or by accident, further reduce vegetation, rabbits prevent any large-scale regeneration.
7. Small sand-blows become larger as a result of soil properties.
8. Rookeries collapse, bare soil areas increase and finally sand-blow areas become extensive and coalesce.

Since the removal of the rabbits, by myxomatosis, has been almost complete it is thought that the use of poisoned bait might clear the island. This should allow regeneration of vegetation and assist the spread of species otherwise kept down by the selective pressure of the rabbits.

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Appendix

List of plant species found on Rabbit Island during visit: plants recorded by Gillham (1961) recorded with an asterisk

Bryophytes

* *Bryum campylothecium*. Common in rock crevices.
Campylopus introflexus. Frequent in rock crevices.

Vascular Plants, Pteridophytes

* *Pteridium esculentum*. Several communities in sand valley, probably associated with occasional fires.
* *Microsorium* (= Polypodium) *diversifolium*. One only found.
Asplenium obtusatum. A few clumps along W. side, just above splash zone.

Phanerograms

* *Poa poiformis*. Dominant species over most of the island.
* *Scirpus nodosus*. Occasional around coast.
Juncus pallidus. Few patches only found on W. side.
Bulbine bulbosa. Fairly common along S. end of island.
* *Dianella revoluta*. Occasional amongst *Poa*.
* *Cakile maritima*. Found along sand beach.
* *Stellaria media*. In several places along coast, particularly on cliffs on E. side.
Urtica urens. Abundant over all island, possibly an introduction since 1960.
* *Muehlenbeckia adpressa*. One stand only found.
* *Atriplex hastata*. Several clumps around coast.
* *Correa alba*. Occasional patches along W. and S. coasts.
* *Acacia longifolia* var. *sophorae*. Two stands only.
Crassula helmsii (= *recurva*). Very common over all island.

Leptospermum laevigatum. One occurrence only.
Olearia axillaris. Only one stand found.
* *Disphyma australe*. Common along coast and on cliff faces.
* *Carpobrotus rossii*. As above.
Cotula australis. Few found along coast.
* *Senecio lautus*. Dominant species along edges of sand blow, found occasionally elsewhere.
* *Carduus tenuiflorus*. Dead plants and seedlings found in sand valley.
Sonchus oleraceus. A few specimens found along W. side.
* *Lobelia alata*. Common in rock crevices near sea.
* *Cyathodes acerosa*. One specimen only found.

Gillham found the following species which were not recorded during this visit: *Vulpia bromoides, Ammophila arenaria, Bulbine semibarbata, Calandrina calyptrata, Spergularia media, Crassula sieberiana, Cotula coronopifolia*; and the following were found on 1.3.66: *Atriplex cinerea, Tetragonia tetragonioides* and *Solanum laciniatum*.

Thus a total of 35 vascular plant species have been recorded from Rabbit Island.

Explanation of Plate

PLATE 35

Aerial photograph looking N. along Rabbit Island. In the foreground the cover of *Poa* is shown with bare soil and *Poa* debris between the tussocks. The sand beach leads up to the valley and sand blow above. Note triangulation point in upper right corner. (Photograph by Dr. G. Ettershank.)